



**U.S. Department of Energy
Technical Qualification Program**

Occupational Safety Qualification Standard

Study Guide

For the

***Mechanical Systems
Qualification Standard***

April 1996

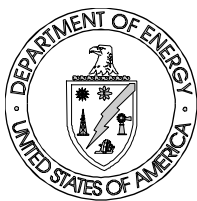


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Competency 1.20 **Mechanical systems personnel shall demonstrate a working level knowledge of the safety and health fundamentals of mechanical systems and/or components.**

1. Supporting Knowledge and Skills

- a. Discuss the hazards associated with the use of corrosives (acids and alkalies).
- b. Describe the general safety precautions necessary for the handling, storage, and disposal of corrosives.
- c. Discuss the general safety precautions regarding toxic compounds.
- d. Describe the criteria used to determine if a compound is a health hazard and discuss the ways toxic compounds may enter the body.
- e. Discuss the general safety precautions regarding the use, handling, and storage of compressed gases, including hydrogen, oxygen, and nitrogen.
- f. Explain the difference between a flammable material and a combustible material.
- g. Describe the general safety precautions regarding the use, handling, and storage of flammable and combustible materials.
- h. Identify and discuss elements of a mechanical safety program, including the following:
 - Protective equipment
 - Lockout and tagout
 - Stored energy
 - Component labeling

**2. Self-Study Activities (corresponding to the intent of the above competency)**

NOTE: Below are three web sites containing many of the references you may need.

Web Sites		
Organization	Site Location	Notes
Department of Energy	http://cted.inel.gov/cted/index.htm	DOE Standards, Guides, and Orders.
OSHA	http://www.osha-slc.gov/	OSHA documents and search engine
U.S. House of Representatives	http://law.house.gov/cfr.htm	Searchable Code of Federal Regulations

Read Chapter 1, “Overview of Industrial Hygiene,” of the National Safety Council, *Fundamentals of Industrial Hygiene*.

Review NIOSH, *Pocket Guide to Chemical Hazards*.

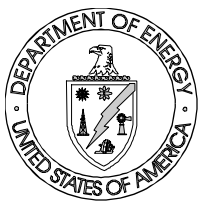
EXERCISE 1.20-A Discuss the hazards associated with the use of corrosives (acids and alkalies).

EXERCISE 1.20-B Describe the general hazards associated with corrosive material, providing examples of both types of corrosives.

EXERCISE 1.20-C Referring to NIOSH Publication 94-116, *Pocket Guide to Chemical Hazards*, what are the general incompatibilities and reactivities for the following corrosive materials? What are the general personal protection precautions one must take with these?

- nitric acid
- sulfuric acid
- anhydrous ammonia
- sodium hydroxide

EXERCISE 1.20-D Discuss the general safety precautions regarding toxic compounds.



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Scan 29 CFR 1910.101, *Compressed Gases*; 29 CFR 1910.102, *Acetylene*; 29 CFR 1910.103, *Hydrogen*; 29 CFR 1910.104, *Oxygen*; and NIOSH Publication 94-116, *Pocket Guide to Chemical Hazards*.

Review 29 CFR 1910.120, *Hazardous Waste Operations and Emergency Response*.

Read OSHA 2202, *Construction Industry Standards*.

- EXERCISE 1.20-E What are the three basic hazards associated with compressed gas cylinders?
- EXERCISE 1.20-F Name four general risks associated with safety, health, or chemical hazards.
- EXERCISE 1.20-G Discuss the ways toxic compounds may enter the body.
- EXERCISE 1.20-H Referring to OSHA 2202, discuss the general safety precautions regarding the use, handling, and storage of compressed gases.

Scan 29 CFR 1910.106, *Flammable and Combustible Liquids*.

Scan OSHA 2202, *OSHA Construction Industry Standards*.

- EXERCISE 1.20-I Referring to 29 CFR 1910.106, explain the difference between a flammable material and a combustible material.
- EXERCISE 1.20-J Referring to OSHA 2202, describe the general safety precautions regarding the use, handling, and storage of flammable and combustible materials.



3. Summary

(From: *Fundamentals of Industrial Hygiene*)

The majority of the occupational health hazards arise from inhaling chemical agents in the form of vapors, gases, dusts, fumes, and mists, or by skin contact with these materials. The degree of risk of handling a given substance depends on the magnitude and duration of exposure. The required information about these chemical hazards can be obtained from the Material Safety Data Sheet (MSDS) that must be supplied by the chemical manufacturer or importer to the purchaser for all hazardous materials that are subject to 29 CFR 1910.1200.

Explosives are those substances, mixtures, or compounds capable of entering into a combustion reaction so rapidly and violently as to cause an explosion. Corrosives are capable of destroying living tissue and have a destructive effect on other substances, particularly on combustible materials; this effect can result in a fire or explosion. Flammable liquids are those liquids with a flash point of 38°C (100°F) or less, although those with higher flash points can be both combustible and dangerous. Toxic chemicals are those gases, liquids, or solids that, through their chemical properties, can produce injurious or lethal effects upon contact with body cells. Oxidizing materials are those chemicals that will decompose readily under certain conditions to yield oxygen. They may cause a fire in contact with combustible materials, and can react violently with water or fire. Dangerous gases are those gases that can cause lethal or injurious effects and damage to property by their toxic, corrosive, flammable, or explosive physical and chemical properties.

The toxicity of a material is not synonymous with its being a health hazard. Toxicity is the capacity of a material to produce injury or harm. Hazard is the possibility that exposure to a material will cause injury when a specific quantity is used under certain conditions. The key elements to be considered when evaluating a health hazard are:

- How much of the material must be in contact with a body cell and for how long to produce injury?
- What is the probability that the material will be absorbed or come in contact with body cells?
- What is the rate of generation of airborne contaminants?
- What control measures are in use?

The effects of exposure to a substance depend on dose, rate, physical state of the substance, temperature, site of absorption, diet, and general state of a person's health.



4. Exercise Solutions

EXERCISE 1.20-A Discuss the hazards associated with the use of corrosives (acids and alkalies).

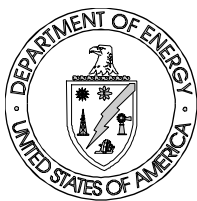
ANSWER 1.20-A Corrosives are capable of destroying living tissue and have a destructive effect on other substances, particularly on combustible materials; this effect may result in a fire or explosion.

EXERCISE 1.20-B Describe the general hazards associated with corrosive material, providing examples of both types of corrosives.

ANSWER 1.20-B (Any reasonable paraphrase of the following.) Corrosive hazards are substances that cause the deterioration of other materials. A corrosive may eat through and destroy metal, body tissue, plastics, and other materials. Corrosives can be acids or alkali and in the form of a solid, liquid, or gas. Great caution should be taken when working near corrosive materials; they burn on contact and breathing corrosive materials can cause life-threatening damage. Some common corrosives include chlorine, hydrochloric acid, nitric acid, sulfuric acid, anhydrous ammonia, and sodium hydroxide. The strength of a corrosive material is generally measured by how much its pH deviates from neutral (pH 7).

EXERCISE 1.20-C Referring to NIOSH Publication 94-116, *Pocket Guide to Chemical Hazards*, what are the general incompatibilities and reactivities and personal protection precautions for the following corrosive materials?

- nitric acid
- sulfuric acid
- anhydrous ammonia
- sodium hydroxide



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ANSWER 1.20-C

General Incompatibilities and Reactivities for Four Corrosive Materials		
Corrosive Material	Incompatibilities and Reactivities	Personal Protection Precautions
Nitric acid	Combustible materials, metallic powders, hydrogen sulfide, carbides, alcohols	Prevent skin contact, prevent eye contact, wash skin on contact, provide eyewash, quick drench
Sulfuric acid	Organic materials, chlorates, carbides, fulminates, water, powdered metals; reacts violently with water when heated	Prevent skin contact, prevent eye contact, wash skin on contact, provide eyewash, quick drench
Anhydrous ammonia	Strong oxidizers, acids, halogens, salts of silver and zinc; corrosive to copper and galvanized surfaces	Prevent skin contact, prevent eye contact, wash skin on contact, provide eyewash, quick drench
Sodium hydroxide	Water, acids, flammable liquids, organic halogens; corrosive to metals	Prevent skin contact, prevent eye contact, wash skin on contact, provide eyewash, quick drench

EXERCISE 1.20-D Discuss the general safety precautions regarding toxic compounds.

ANSWER 1.20-D Toxic chemicals are those gases, liquids, or solids that, through their chemical properties, can produce injurious or lethal effects upon contact with body cells. The majority of toxic chemicals are safe when packaged in their original shipping containers or contained in a closed system.

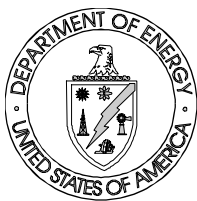
EXERCISE 1.20-E What are the three basic hazards associated with compressed gas cylinders?

ANSWER 1.20-E

- High pressures
- Displacement of breathable air
- Contents that burn or have other hazardous characteristics



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EXERCISE 1.20-F Name four general risks associated with safety, health, or chemical hazards.

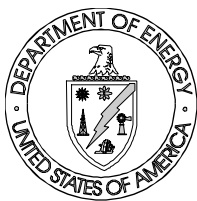
ANSWER 1.20-F (Any four of the following.)

- Exposures exceeding permissible exposure limits
- IDLH concentrations
- Potential skin absorption and irritation
- Potential eye irritation
- Explosion sensitivity
- Flammability and combustibility
- Oxygen deficiency

EXERCISE 1.20-G Discuss the ways toxic compounds may enter the body.

ANSWER 1.20-G

Primary Routes and Methods of Entry	
Route	Description
Inhalation	Involves those airborne contaminants that can be inhaled directly into the lungs and can be physically classified as gases, vapors, and particulate matter which includes dusts, fumes, smoke, aerosols, and mists.
Absorption	Chemicals can be absorbed through the skin and more rapidly through cut or abraded skin than through intact or unbroken skin. Some substances are absorbed by way of the openings for hair follicles, while others dissolve in the fats and oils of the skin. Some organic chemicals can produce systemic poisoning by direct contact with the skin.
Ingestion	When consumed, toxic compounds are capable of being absorbed from the gastrointestinal tract into the blood.



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EXERCISE 1.20-H Referring to OSHA 2202, discuss the general safety precautions regarding the use, handling, and storage of compressed gases.

ANSWER 1.20-H According to OSHA 2202, the following general safety precautions apply to the use, handling, and storage of compressed gases:

- Valve protection caps shall be in place when compressed gas cylinders are transported, moved, or stored.
- Cylinder valves shall be closed when work is finished and when cylinders are empty or are moved.
- Compressed gas cylinders shall be secured in an upright position at all times, except if necessary for short periods of time when cylinders are actually being hoisted or carried.
- Cylinders shall be kept at safe distance or shielded from welding or cutting operations. Cylinders shall be placed where they cannot become part of an electrical circuit.
- Oxygen and fuel gas regulators shall be in proper working order while in use.

EXERCISE 1.20-I Explain the difference between a flammable material and a combustible material.

ANSWER 1.20-I A combustible liquid is any liquid having a flashpoint at or above 100°F (37.8°C) and a flammable liquid is any liquid having a flashpoint below 100°F (37.8°C).

EXERCISE 1.20-J Referring to OSHA Standard 2202, describe the general safety precautions regarding the use, handling, and storage of flammable and combustible materials.

ANSWER 1.20-J From OSHA 2202, section 21, Flammable and Combustible Liquids:

- Only approved containers and portable tanks shall be used for storage and handling of flammable and combustible liquids.
- No more than 25 gallons of flammable or combustible liquids shall be stored in a room outside of an approved storage cabinet. No more than 60 gallons of flammable or 120 gallons of combustible liquids shall be stored in any one storage cabinet. No more than three storage cabinets may be located in a single storage area.



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- c. Inside storage rooms for flammable and combustible liquids shall be of fire-resistive construction, have self-closing fire doors at all openings, four-inch sills or depressed floors, a ventilation system that provides at least six air changes within the room per hour, and electrical wiring and equipment approved for Class I, Division 1 locations.
- d. Storage in containers outside buildings shall not exceed 1,100 gallons in any one pile or area. The storage area shall be graded to divert possible spills away from building or other exposures, or shall be surrounded by a curb or dike. Storage areas shall be located at least 20 feet from any building and shall be free from weeds, debris, and other combustible materials not necessary to the storage.
- e. Flammable liquids shall be kept in closed containers when not actually in use.
- f. Conspicuous and legible signs prohibiting smoking shall be posted in service and refueling areas.